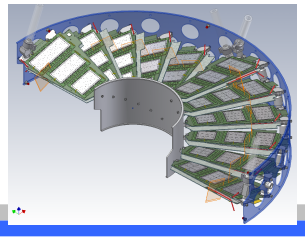



# Forward Pixel Sensor Alignment

19 January 2006

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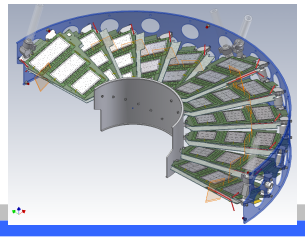
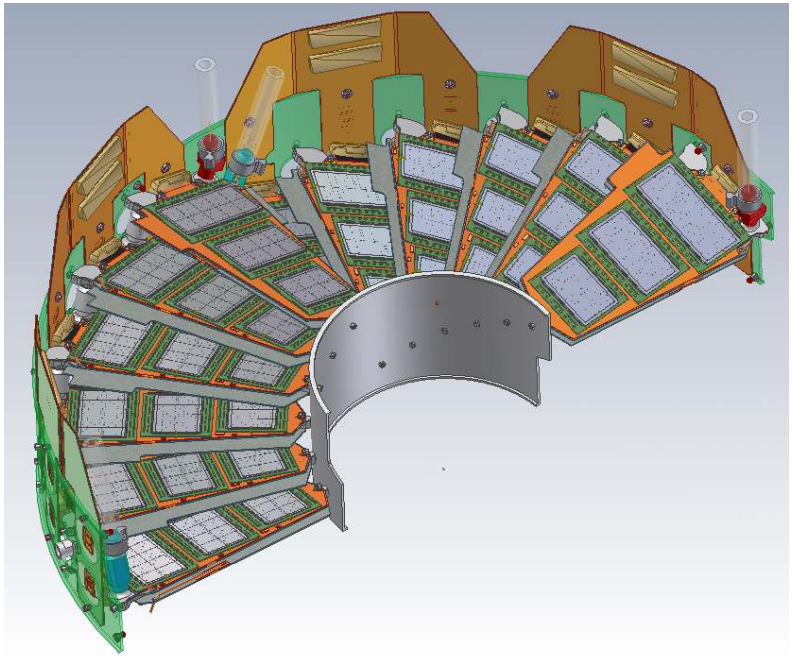
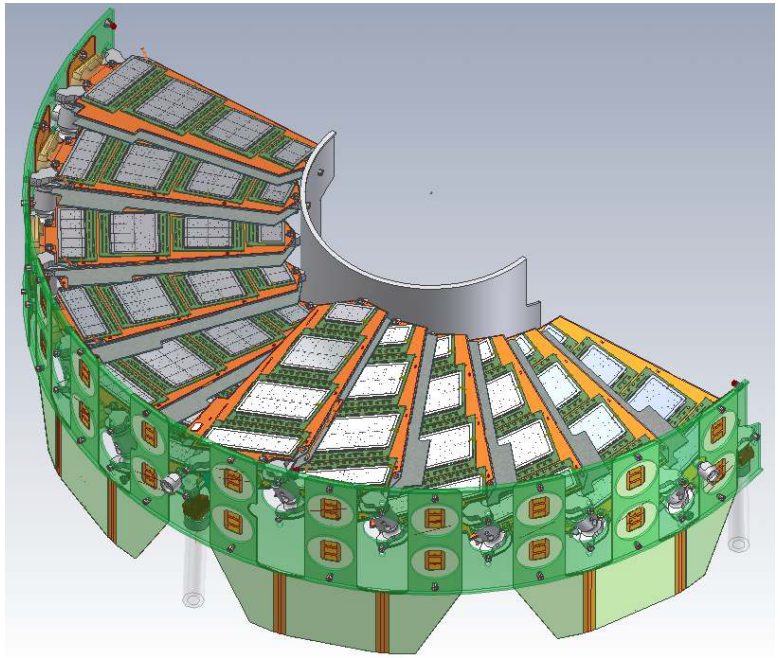
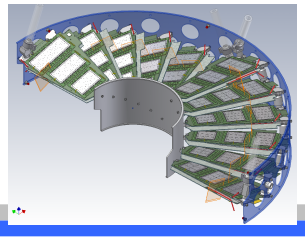


# *Alignment Approach*

- Location of sensors on half-disks must be known for alignment
- Sensor locations will be measured after half-disk assembly
- Therefore construction tolerances are not tight:
  - ⇨ Sensors positioned on panels ~50 μm
  - ⇨ Panels positioned on half-disks to within a fraction of a mm

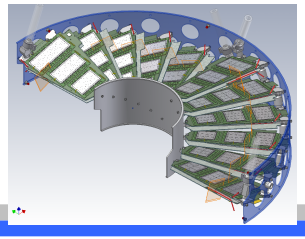






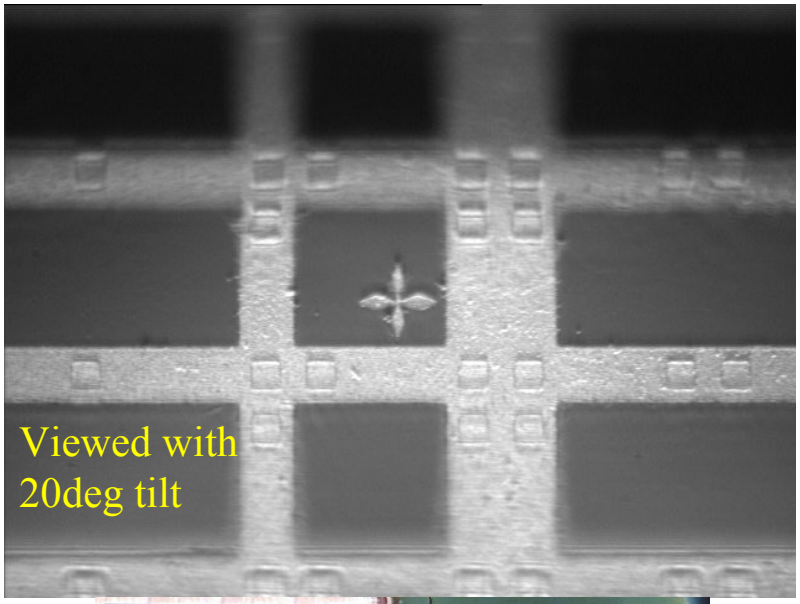
# *Process Outline*

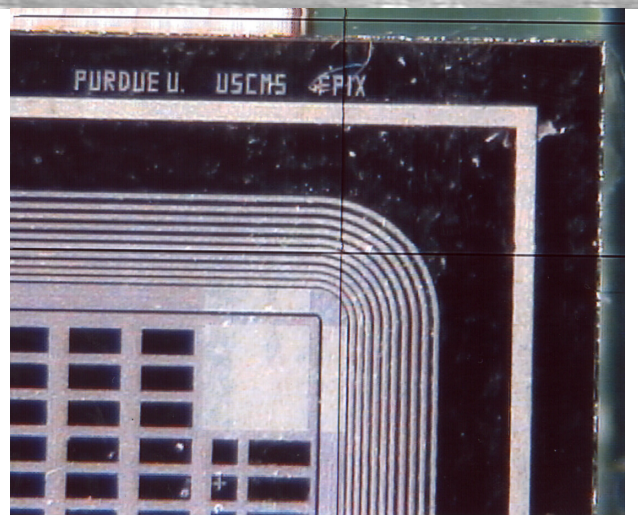
- Measure sensors on panels relative to each other (optical)
- Install panels
- Measure visible sensors relative to half-disk features (optical + touch probe)
- Install half-disk in service cylinder
- Measure half-disk survey features relative to the service cylinder (touch probe)
- Translate sensor position data into higher level coordinate systems to help describe detector alignment

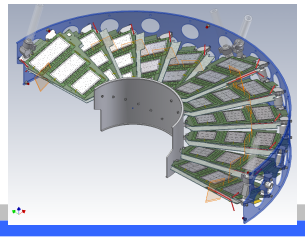


# *Panel Survey*

- Inspect sensor positions on a panel during the assembly process based on fiducial & guard ring edge measurements
  - ⇨ OGP CMM accuracy over a panel <3 microns XY but 10+ in Z (depends on optics selected)
  - ⇨ Positions described relative to the 2x4 sensors
  - ⇨ $N_{chips}$ x 20 fiducials per sensor
  - ⇨ Selection of just which features to measure will require careful consideration

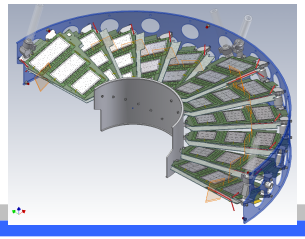




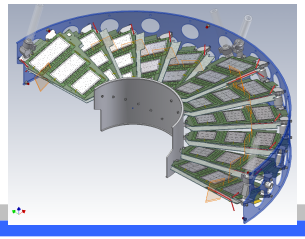
# *Half-Disk Survey*

- After panel installation onto the half disk, sensors must be measured relative to the ruby ball positions (one side at a time)
- OGP CMM has dual measurement heads
  - ⇨ Touch probe measurement of ruby balls
    - XYZ accurate to within a few microns over a half-disk
  - ⇨ Optical measurement of sensors
    - Need at least 3 XYZ points per sensor viewed
    - X&Y accuracy good to about 3 microns over a half-disk
    - Z accuracy on 20$^{o}$ tilted surface is not as good, and will depend on lens & magnification choices and focusing procedures. 20 to 30 micron accuracy?
  - ⇨ The two heads can be cross-calibrated to within a few microns

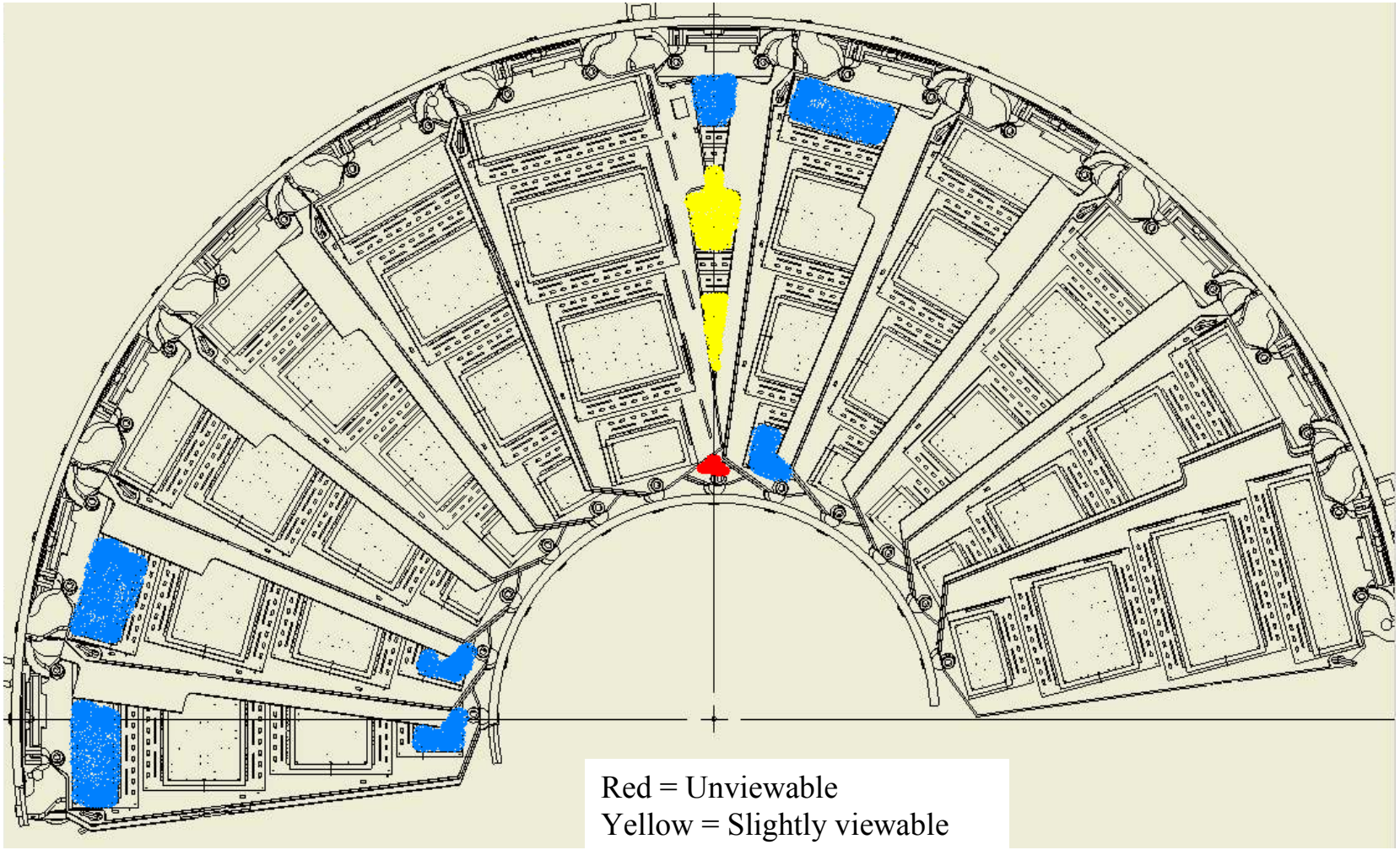


# *Half-Disk Survey*

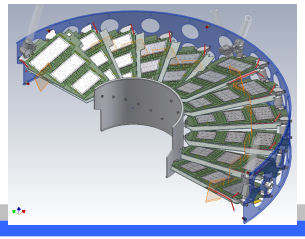
- Sensors only partially viewable on a half-disk
  - ⇨ Positions of unmeasured sensors must be extrapolated from the inspected positions of viewable sensors
- OGP CMM optical working distance is sufficient to reach the 2x4 sensor on each half-disk (even with a 5X lens)
- Lens options are being investigated for coverage of sensors at the extreme inner and outer radii.
  - ⇨ Higher mag. improves accuracy in X, Y, and Z
  - ⇨ Higher mag. reduces working distance, resulting in clearance issues
  - ⇨ Do we trade off Z resolution for more XY coverage?



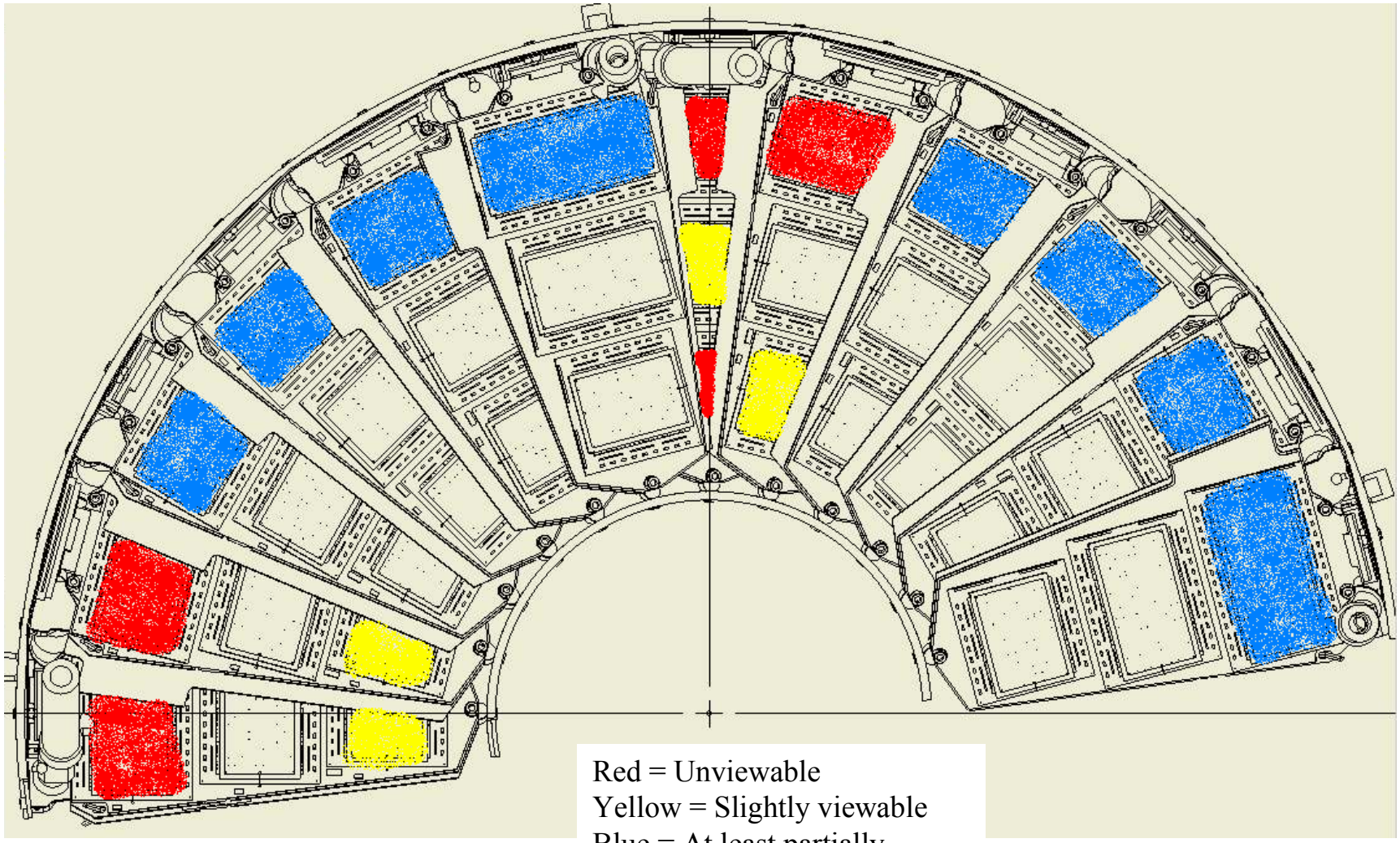
# *Half-Disk Survey*



Red = Unviewable
Yellow = Slightly viewable
Blue = At least partially viewable with a 1X lens



# *Half-Disk Survey*



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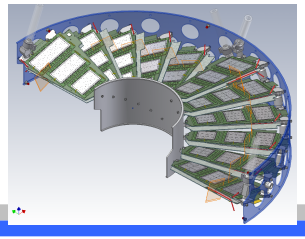
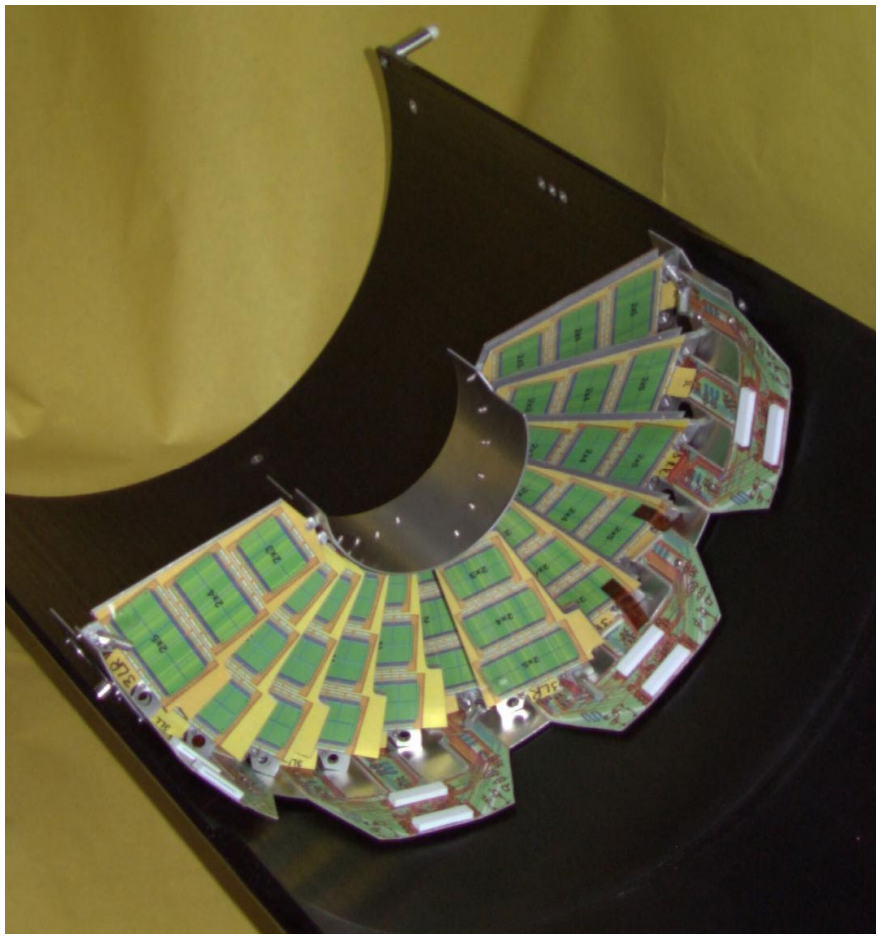
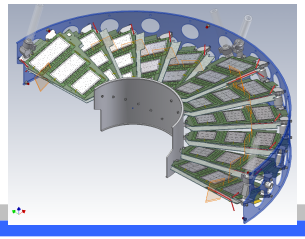


# *Service Cylinder*

- Install half-disks into service cylinder
- In the service cylinder coordinate system (based on the mounting balls), survey the ruby balls on each face of the half-disks with a CMM touch probe
- Service cylinders installed into the CMS detector
- Alignment data sets to be translated into global CMS coordinate system
  - ⇨ Sensors on panels
  - ⇨ Sensors/panels on half-disks
  - ⇨ Half-disks in service cylinder
  - ⇨ Service cylinders in CMS





# *FPix Sensor Alignment*

- Input from the software / tracking effort:
  - ⇨ Communication between tracking and mechanics (Mikhail Kubantsev, FNAL) to coordinate alignment information
  - ⇨ Preferences on the organization of data?
  - ⇨ Other?